

## CHAPTER 5

### MEASURING TECHNIQUES

#### 5-1. Criteria

In order to evaluate the nature and magnitude of air pollution, establish remedial measures, and determine control programs, it is necessary to test for the existence of pollutants. In the upgrading of existing installations, compliance is determined through "point source emission rate tests." Revisions to the regulations regarding air pollution test requirements for federal installations appear in the Federal Register.

#### 5-2. Stack and source measurement techniques

The point source emission rate test methods and requirements are covered under Environmental Protection Agency Regulations on Standards of Performance for New Stationary Sources, 40 CFR 60 and subsequent revisions. The techniques are listed in table 5-1.

*Table 5-1*  
*EPA emissions sampling techniques*

EPA Method Number	To Determine:
1	Sampling site and the maximum number of sampling points required for the extraction of a representative sample of flue gas from a stationary source.
2	Velocity and volumetric flow rate of flue gas.
3	Concentration by volume of carbon dioxide (CO <sub>2</sub> ), carbon monoxide (CO) and Oxygen (O <sub>2</sub> ) in flue gas, also excess air and dry molecular weight.
4	Moisture content of flue gas.
5	Particulate emissions from stationary sources.
6	Sulphur dioxide (SO <sub>2</sub> ) concentration in flue gas.
6A	SO <sub>2</sub> , CO <sub>2</sub> , moisture.
6B	SO <sub>2</sub> and CO <sub>2</sub> daily average emission.
7	All nitrogen oxides (NO <sub>x</sub> ) in flue gas except nitrous oxide (NO).
7A	All NO <sub>x</sub> emissions except nitrous oxides (NO).
8	Sulphur dioxide and sulphuric acid (H <sub>2</sub> SO <sub>4</sub> ) mist concentrations in flue gas.
9	Opacity of visible emissions.
10	Carbon monoxide (CO) emissions from stationary sources when specified for determining compliance with new Source Performance Standards.
17	Particulate emissions from stationary sources (in-stack filtration method).
18	Gaseous organic compound emissions determination by gas chromatography.

#### 5.3 Meteorological and ambient air measurement

*a. Measurements.* Air quality measurements are used to trace emission sources and determine if these sources comply with federal, state, and local air quality

standards. For the determination of possible violations of air quality, the continuous monitoring of pollutant concentrations is normally required for a one-year period. Air quality measurements are a function of the sampling site, the local meteorology, the methods used, and the existing pollutant concentration in the atmosphere. Personnel knowledgeable and experienced in meteorology and air quality testing are needed to conduct and evaluate air-quality measurements.

*b. Sampling technique.* The criteria for instrumentation, calibration, and use of EPA-approved sampling techniques are covered under 40 CFR 53 Environmental Protection Agency Regulations on Ambient Air Monitoring Reference and Equivalent Methods. See table 5-2.

*Table 5-2*  
*Air quality sampling method summary*

Pollutant	Method	EPA Approved	Unapproved
CO	*Nondispersive infrared	X	—
	*Flame ionization	—	X
SO <sub>2</sub>	West-Gaeke sulfuric acid	X	
	*West-Gaeke colorimetric	—	X
	*Conductimetric	—	X
	*Coulometric	—	X
	*G. C. flame photometric	—	X
	*Pulsed fluorescence	—	X
Oxidants (O <sub>3</sub> )	*Chemiluminescence	X	—
	Colorimetric	—	X
	*Coulometric	—	X
NO <sub>2</sub>	Gas Phase		
	Chemiluminescence	X	—
	*Colorimetric	—	X
	*Coulometric	—	X
Hydrocarbon (corrected for methane)	Sodium arsenite bubbler	—	X
	Gas Chromatography	X	—

\*Continuous sampling method

- (1) Continuous sampling is the recommended technique for obtaining the most reliable information concerning the variation of pollutant concentration in the real atmosphere. Discrete sampling can be used for plume tracking and random checking. Discrete sampling should be used with caution, however, when measuring any of several pollutants that have daily variations. (For example, ozone has very low concentrations at night.) In addition, use of discrete sampling methods will often result

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	*Pulsed fluorescence	—	X
Oxidants (O <sub>3</sub> )	*Chemiluminescence	X	—
	Colorimetric	—	X
	*Coulometric	—	X
NO <sub>2</sub>	Gas Phase	—	—
	Chemiluminescence	X	—
	*Colorimetric	—	X
	*Coulometric	—	X
Hydrocarbon (corrected for methane)	Sodium arsenite bubbler	—	X
	Gas Chromatography	X	—

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in economically unacceptable manpower requirements. In these cases, sampling with continuous instruments and recording on data charts provides a lower cost solution.

- (2) Air quality regulations require the measurement of extremely small pollutant concentrations (1/100 of a part per million by volume). Sensitive instruments capable of detecting small concentrations are needed.

*c. Sampling method for carbon monoxide.* The federal reference method for measuring carbon monoxide is the instrumental nondispersive infrared technique. A typical instrument consists of a reference cell filled with CO free air, and a sample, or detector, cell. The difference in transmittance of infrared radiation passing through the sample cell and the reference cell is sensed by a photon detector. The difference is a measure of the optical absorption of the CO in the sample cell and is proportional to the CO concentration in the sample. The signal from the detector is amplified and used to drive an output meter as a direct measure of CO concentration. This method is precise and accurate.

*d. Sampling method for sulfur dioxide.* The West-Gaeke sulfuric acid method is the Federal reference method for measuring sulfur oxides. The West-Gaeke method is a discrete bubbler technique which involves bubbling ambient air through an impinger for 24 hours. Sulfuric acid is added to the absorber to eliminate interferences from oxides of nitrogen.  $\text{SO}_2$  is collected in a tetrachloromercurate solution. When acid bleach pararosaniline is added to the collected  $\text{SO}_2$  together with formaldehyde, a red-violet compound is formed which is then measured spectrophotometrically. This method is a discrete instrumental sampling method, but may be modified for continuous use.

*e. Sampling method for oxidants and ozone.* The instrumental-chemiluminescence method is the federal reference method for measuring ozone. Upon mixing ambient air and ethylene in the testing instrument, ozone reacts with the ethylene to emit light. This light is measured by a photomultiplier. If the air and ethylene flow rates are constant, and the proportion of air and ethylene therefore known, the resulting signal can be related to ozone concentration. Analyzers are calibrated with a known ozone concentration.

*f. Sampling method for nitrogen dioxide.* The federal reference method for  $\text{NO}_2$  is the indirect measurement of the concentration of nitrogen dioxide by photometrically measuring the light intensity of wavelengths greater than 600 nanometers resulting from the gas phase chemiluminescent reaction of nitric oxide (NO) with ozone ( $\text{O}_3$ ).

*g. Sampling method for total hydrocarbons.* Gas chromatography flame ionization is the federal reference method of measuring total hydrocarbons.

*h. Sampling method for particulates.*

- (1) *Total suspended particulates.* The high volume air sample is the federal reference method for measuring total suspended particulates. Air is drawn (at 40 to 60  $\text{ft}^3/\text{min}$ ) through a glass fiber filter by means of a blower, and suspended particles having an aerodynamic diameter between 100 and 1.0 micron are collected. The suspended particulate is calculated by dividing the net weight of the particulate by the total air volume samples and is reported in  $\text{ug}/\text{m}^3$ .

- (2) *Coefficient of haze (COH).* A few states have standards for a particulate measurement called the coefficient of haze. This measurement is reported in units of COH/1000 linear feet of sampled air. In this method, air is drawn through a small spot on a circle of filter paper until the equivalent of a 1000 feet long column of air of the diameter of the spot has passed through the filter paper. Transmittance through this spot then serves as a measurement of particulate material collected on the filter. There are considerable doubts as to the usefulness and true meaning of COH data, since the transmittance recorded is a function of the nature of the particulate as well as the total weight sampled.

- (3) *Dustfall (settleable particulates).* Several states have standards for the amount of particulate that settles out of the air over a given length of time (one common unit is grams/square meter/30 days). The method of collection is generally the dust bucket. A dust bucket is a 15-inch deep metal or plate container with a 6-inch opening that is exposed to the air generally for a period of one month. Dust buckets should be partially filled with distilled water (or antifreeze) which prevents the transporting of dust out of the buckets by strong winds. This water also acts as a wash at analysis time. After evaporating the water, the remaining material is weighed and the residues are converted to the required units.

*i. Traceable compounds.* Test methods for compounds other than those for which standards exist are often useful in evaluating stack dispersion. If unusual fuel additives are used, or if incinerators are used to dispose of specialized materials, laboratory chemists can often devise sampling methods to measure these compounds in the atmosphere.

*j. Ringelmann standards.* Particulate matter such as soot, fly ash, and droplets of unburned combustibles present in exhaust gases tend to impart blackness or opacity to a plume. It is assumed that the darker the shade of gray or black, the greater the concentration of particulate matter present in a plume. The Ringelmann

Chart offers a set of standards with which to measure the opacity of an effluent plume. By the comparison of the blackness of a plume to the blackness of a series of graduated light diffusers, a Ringelmann number corresponding to a percent opacity can be assigned to the plume (see table 5-3). It should be noted that while Ringelmann numbers give a relative indication of plume opacity, they bear no direct relationship to plume particulate loading. They should supplement but not replace point-source emission tests.

*Table 5-3*  
*Ringelmann standards*

<u>Ringelmann</u>	<u>Opacity (percent)</u>
No. 1	20
No. 2	40
No. 2-½	50
No. 3	60
No. 3-½	70
No. 4	80
No. 4-½	90
No. 5	100

#### **5-4. Flue gas sampling ports**

Sampling ports are approximately 4 inches in diameter, extend out approximately 4 inches from the stack, and

have a removable cover. On double wall stacks sampling ports may consist of a 4-inch diameter pipe extending from 4 inches outside the stack to the inner edge of the inner stack wall. Accessible sampling ports shall be provided and located so that the cross sectional area of the stack or flue can be traversed to sample the flue gas in accordance with the applicable current federal or state regulations for fuel burning equipment.

#### **5-5. Air pollution project contacts**

U.S. Army Environmental Hygiene Agency (AEHA), Aberdeen Proving Grounds, MD, may be contacted for the respective service air pollution projects on the following:

- a.* Source testing to characterize pollutants for design controls.
- b.* Consultation on test performance standards and witnessing tests.
- c.* Testing of installed air pollution abatement equipment for compliance with regulatory standards.